

REMARKS

Claims 1-14 are pending in the application. Claims 1, 2, 5, 7 and 14 have been amended to disclaim the cited art and to better describe certain aspects of the invention. Favorable reconsideration in light of the amendments and the remarks which follow is respectfully requested.

I. The Obviousness Rejections

Claims 1-11, 13, and 14 stand rejected under 35 USC 103(a) over Knauss (U.S. Patent 6,255,424) in view of Yamamoto (JP 2002-105209). Claim 12 stands rejected under 35 USC 103(a) over Knauss in view of Yamamoto and in view of Huyskens (J. Molec. Liq., (1998), 78, 151). Applicant respectfully traverses these rejections.

Discussion of Knauss

As is well known in the art, different grafting methodologies have been described in the scientific and patent literature and can be described as “grafting through”, “grafting onto” (or “grafting to”), and “grafting from” techniques. See for example:

http://www.cmu.edu/maty/materials/Synthesis_of_well_defined_macromolecules/graft-copolymers.html#graft.

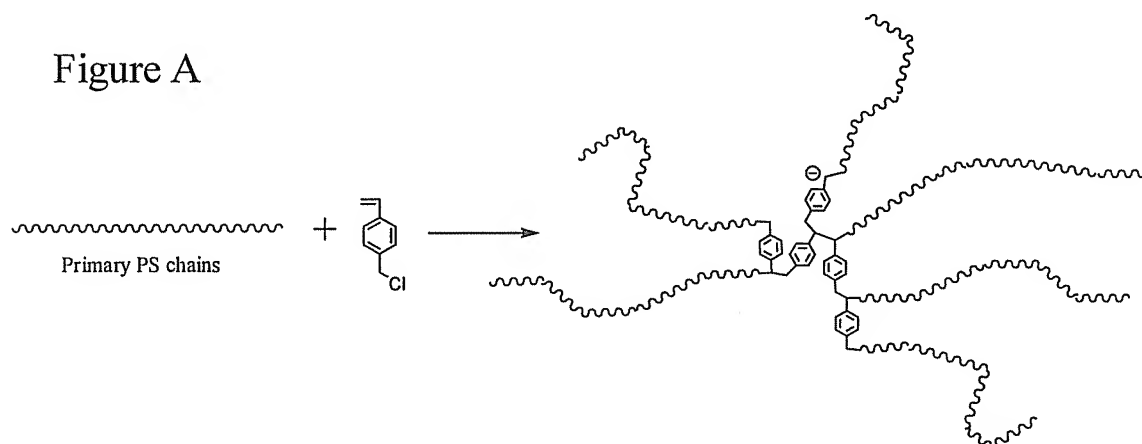
Grafting techniques can be further categorized as “divergent” methods, whereby the branched molecules grow from the inside out, and “convergent” methods, whereby growth takes place from the outside of the molecules inwards. The “grafting from” and “grafting onto” techniques belong to the “divergent” category. In the first case (“grafting from”) side chains are grown from a substrate acting as a polyfunctional initiator, while in the second case (“grafting onto”) side chains are coupled with a substrate acting as a polyfunctional linking agent. In both cases, linear side chains are added in successive grafting or coupling reactions on the outside of the branched structure.

The “grafting through” method normally falls in the “convergent” category because it typically involves coupling “macromonomers”, which are preformed polymer chains with a terminal double bond, into progressively larger branched units, often in a “one-pot” reaction. Successive coupling reactions produce branched fragments with a single reactive site on the fragment (as in the method of Knauss), called the “focal point” of the molecule. Growth of the branched structures in a “convergent” scheme occurs through successive reactions of the focal points of branched fragments combining to yield larger branched structures. The chains added in the first coupling cycles thus form the outside of the branched structure, so that it grows from the outside in.

The method taught by Knauss specifically comprises the reaction of ‘living’ chains (prepared by anionic polymerization) with a bifunctional monomer (e.g. chloromethylstyrene), either by itself or in combination with a monofunctional monomer (e.g. chloromethylstyrene and styrene). This leads to a series of coupling reactions producing branched polymer structures as described in Figures 3 and 4 (only chloromethylstyrene) and Figure 5 (chloromethylstyrene and styrene) of the Knauss patent. Subsequent grafting reactions likewise involve the formation of a macromonomer as a first step, followed by attack of the double bond by the anionic reactive center located on the branched species. This addition of the living species across the double bond on the building block is the step defining this process as a “grafting through” methodology. Knauss clearly specifies the method taught therein as being specifically restricted to “convergent synthesis” and distinguishes same from “divergent synthesis”.

The method taught by Knauss may be summarized by the following reaction scheme (Figure A):

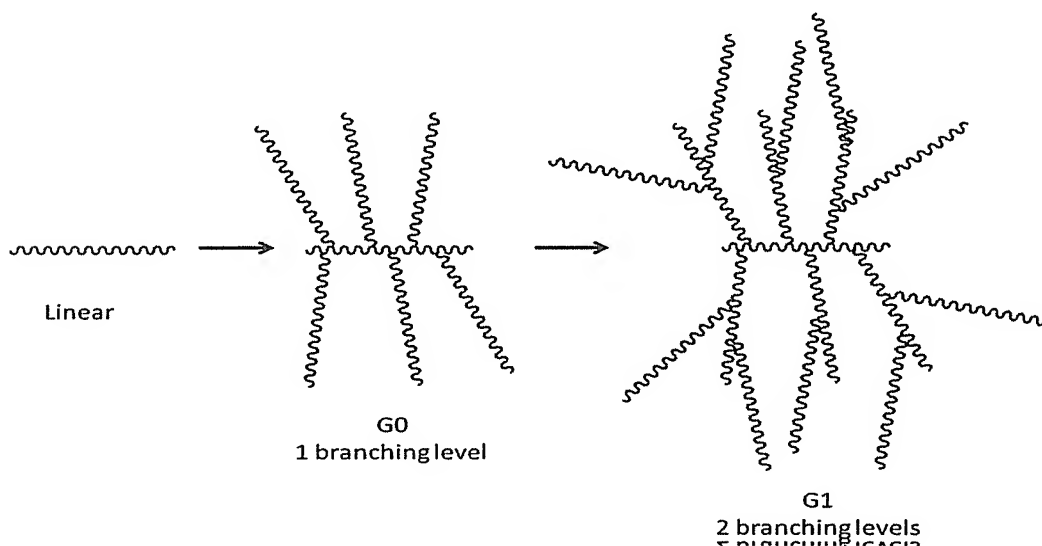
Figure A



By contrast, the branched structure of arborescent polymers as in the present invention is derived from a “grafting onto” method, involving discrete cycles (“generations”) of substrate functionalization and grafting reactions. This is illustrated in Figure 1 of the present application. For the specific case described in Figure 1, a linear polyisoprene substrate is randomly functionalized with a number of epoxide coupling sites and subsequently reacted with living polyisoprenyllithium chains. In this approach, each coupling site on the grafting substrate can potentially be linked with one living chain, and no further reaction of the coupling site is possible. This characteristic defines the “grafting onto” methodology. Because the side-chains grafted on the linear substrate have the same chemical composition (polyisoprene) in the G0 (comb-branched) polymer, the functionalization and grafting reaction cycles can be repeated, leading to successive generations of arborescent polymers (G1, G2).

The method of the present invention may therefore be summarized according to the following reaction scheme (Figure B):

Figure B



Thus, in arborescent polymer synthesis, to which the present invention is directed, a number of coupling sites are generally randomly introduced on the grafting substrate and are subsequently reacted with the living polymer serving as side-chains. Knauss defines this type of process as "divergent synthesis".

Knauss specifically teaches that the subject matter defined therein is directed exclusively to "convergent synthesis" or, in other words, to a "grafting through" method. Therefore, as would be apparent to persons skilled in the art, the teaching in Knauss cannot be equated to a "grafting onto" method, or "divergent synthesis" as in the present invention.

The Examiner states that "Knauss teaches a process for synthesizing dendritic polymers by grafting/coupling a second polymer onto a first". Applicant submits that this is an oversimplification of the teaching in Knauss. Firstly, as discussed above, Knauss is very clearly directed to a "grafting through" method,

which is distinct from the present invention. Moreover, the method taught by Knauss relies on the presence of a single reactive center per branched molecule, which acts as “coupling site”, or “focal point” as identified in the reference. Further growth (increase in branching functionality) of the molecules depends on successive reactions of this “coupling site” with the macromonomer chains (polystyrene chains capped with chloromethylstyrene) generated in the reaction. Molecular growth therefore depends on the continued existence and accessibility of this coupling site (anionic center) on the branched polymer structure throughout the reaction. Thus, according to Knauss each generation necessarily only includes a single “focal point” and by definition cannot include “one or more” reactive sites.

As discussed above, the method of the present invention involves the presence of a number of coupling sites on the grafting substrate. Current claim 1 recites that epoxide groups are bonded to one or more sites on the first polymer, to which the second polymers are grafted. It is submitted that this feature is not possible with the method of Knauss. Nevertheless, in order to further prosecution of the present application, claim 1 has been amended in order to further clarify the aforementioned feature by stating that “more than one site” of the first polymer are epoxidized. In the result, it is submitted that claim 1 now more clearly recites a “grafting onto” method and is therefore further distinguished from the teaching of Knauss.

In the Office Action, the Examiner states that “the direction of growing the polymers is not claimed”. Applicant respectfully, disagrees. Firstly, it is noted that the preamble of claim 1, the sole independent claim, clearly refers to “arborescent” polymers and also specifies that the method involves the grafting of a number of second polymers to one or more functionalized groups on to a first polymer. As discussed above, it is clearly not possible for the method of Knauss to allow “one or more” second polymers to be bound to a first polymer due to the convergent nature of the method taught therein. As explained above,

the amendment to claim 1 further highlights this distinction.

Discussion of Yamamoto

The Examiner suggests that Yamamoto teaches “a method of making a comb/arborescent polymer”. However, it is respectfully submitted that the Examiner has incorrectly extrapolated the teaching of this reference. Specifically, as indicated in the abstract, Yamamoto is strictly related to the synthesis of comb-branched amphiphilic copolymer structures (which would be equivalent to a G0 arborescent copolymer) by epoxidation of a linear polydiene (mainly polybutadiene) substrate and coupling with polyether side-chains having a hydroxyl chain end under either acid- or base-catalyzed conditions. This method does not equate to an “arborescent” polymer as the Examiner suggests.

Although the method of Yamamoto would comprise a “grafting onto” method, Yamamoto is necessarily limited to the synthesis of comb-branched copolymer architectures alone. The teaching in Yamamoto cannot be used for the production of polymers with a dendritic (multi-level) branched architecture, such as the arborescent polymers of the present invention or even the structure taught by Knauss.

The alleged combination of Knauss and Yamamoto

In the Office Action, the Examiner has combined the teachings of Knauss and Yamamoto and suggests that such combination results in the present invention. Applicant has clearly distinguished the presently claimed invention from both such references and any combination of same. However, it is also respectfully submitted that the combination suggested by the Examiner cannot be made.

As discussed above, Knauss is exclusively directed to a “grafting through” methodology while Yamamoto, like the present invention, is directed to a “grafting onto” methodology. It is submitted that a person of ordinary skill in the

art would understand that these two methods cannot be combined. That is, as discussed above, Knauss very specifically teaches that the substrate molecule must necessarily have a single functional group, or focal point. This is inherent in the convergent nature of the synthesis taught in this reference. Yamamoto is specifically directed to a polymer having a comb structure, which requires the substrate polymer to have multiple functional groups, which is characteristic of the divergent nature of the synthesis of such reference. Thus, as would be clear to persons skilled in the art, the teaching of these references cannot be combined. This conclusion is further supported by the teaching in Knauss itself which clearly distinguishes between convergent and divergent syntheses.

Notwithstanding the foregoing, and as discussed further above, claim 1 of the present application has been amended to further distinguish the presently claimed invention from the teachings of Knauss by requiring the presence of more than one functional group on the substrate polymer.

The combination of Knauss, Yamamoto and Huyskens

The Examiner states, in rejecting claims 8-11, that Knauss teaches a lithium salt as a promoter and then relies upon Huyskens to teach the use of the lithium salt, LiCl, to conclude that claim 12 is obvious.

Firstly, it is noted that claim 12 depends from claim 1. As discussed above, the Examiner's rejection of claim 1 is respectfully submitted as being incorrect. In the result, claim 1 and all claims depending therefrom are submitted to be novel and non-obvious over the references cited by the Examiner.

Secondly, the above notwithstanding, Applicant respectfully submits that the Examiner's reliance on Huyskens in rejecting claim 12 is incorrect. The Examiner refers to col 11, lines 5-10 of Knauss to suggest that this reference teaches the use of a lithium ion promoter. However, the section of Knauss very

clearly states that:

“The polystyrene precursor segments 32 in the living polymerization mixture may have been previously prepared by methods as are well known in the art through anionic addition polymerization of styrene monomer using an alkyl lithium initiator. The relative amounts of styrene monomer and initiator are selected to provide the polystyrene precursor segments 32 of a desired length for the exterior branches of the ultimate dendritic structure.” (Knauss; col. 11, lines 1-9; emphasis added)

From the above excerpt, it is very clear that the alkyl lithium initiator taught in Knauss is used in the preparation of the precursor segments and not in the subsequent reactions for forming the “dendritic” structure. In other words, Knauss does not teach the use of a lithium salt as an additive to promote the coupling reaction for forming the dendritic structure. Thus, unlike the teaching in Knauss, the present invention utilizes the promoters (i.e. initiators) for the latter step as clearly recited in claim 7 (upon which claims 8 to 12 depend). Moreover, although Huyskens demonstrates that the presence of excess lithium salt can influence the rate of polymerization in the preparation of linear chains, the reference does not teach such use with any grafting reactions. Even assuming, in arguendo, that Huyskens were to teach the use of a lithium salt for a grafting, or coupling step, it is submitted that the combination of such teaching with Knauss could only relate to the preparation of the precursor segments of Knauss and not the final dendritic structure.

For at least the above reasons, it is submitted that the combination of Knauss, Yamamoto and Huyskens does not render claim 12, or indeed any claims of the present application, obvious.

Conclusions

In view of the foregoing, Applicant respectfully submits that presently

submitted claims stand clearly novel and non-obvious in view of Knauss, Yamamoto and Huyskens, taken individually or in combination. Applicant therefore requests early reconsideration and allowance of the present application.

The above amendments to the claims are being made solely in an effort to expedite prosecution of this matter. However, Applicant maintains that the claims pending prior to the present amendment include patentable subject matter as set forth in Applicant's response of October 29, 2009. Notwithstanding the actions taken in the present amendment, Applicant does not disclaim any portion of the subject matter contained in the present application and expressly reserves the right to file one or more continuation applications to pursue this and any other subject matter disclosed in the present application.

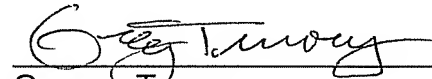
VIII. Petition for Extension of Time

A request for a three-month extension of time is hereby made. Payment is made *via* the EFS filing system.

In the event any fees are due in connection with this document, the Commissioner is authorized to charge those fees to Deposit Account No. 50-1063.

Should the Examiner believe a telephone interview would be helpful to expedite favorable prosecution, the Examiner is invited to contact applicants' undersigned representative at the telephone number below.

Respectfully submitted,
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